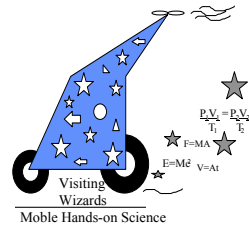


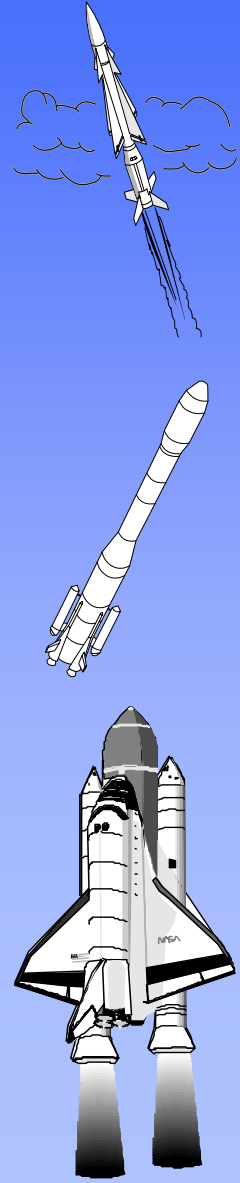
Reach for the Stars!!



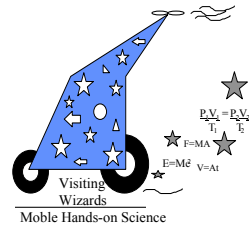
An Introduction into the

Science and Sport
of

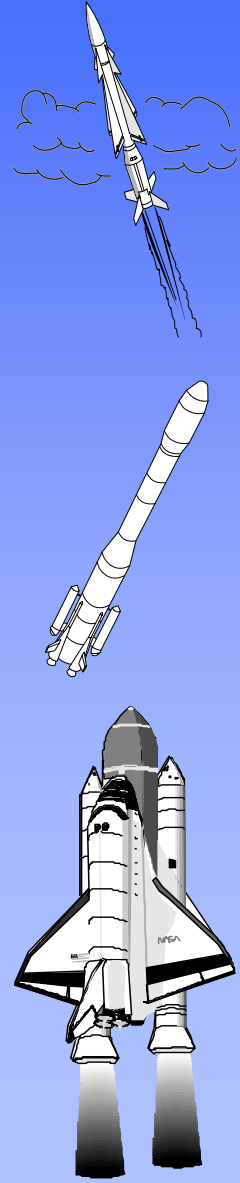
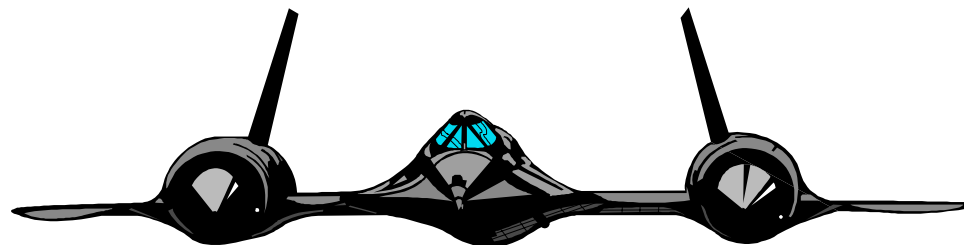
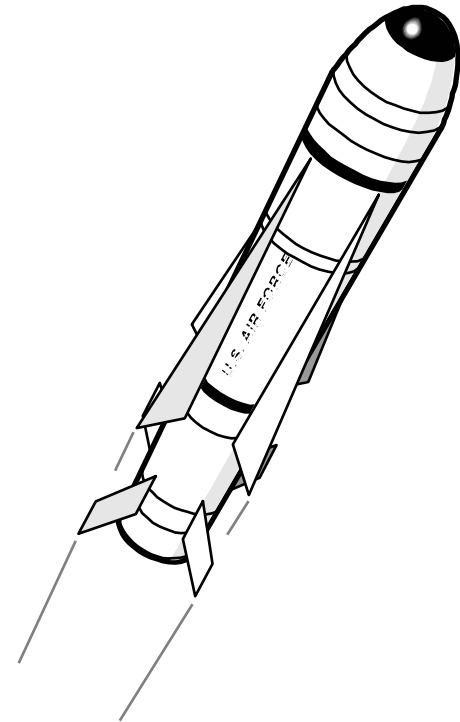
Model Rocketry



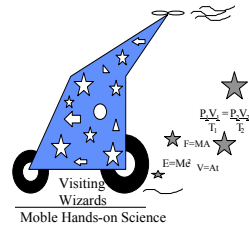
Rocketry Overview



- Space Flight & Rockets
- Rocket Physics & Safety
- Model Rocketry
- Range Prep & Safety
- LAUNCH!!

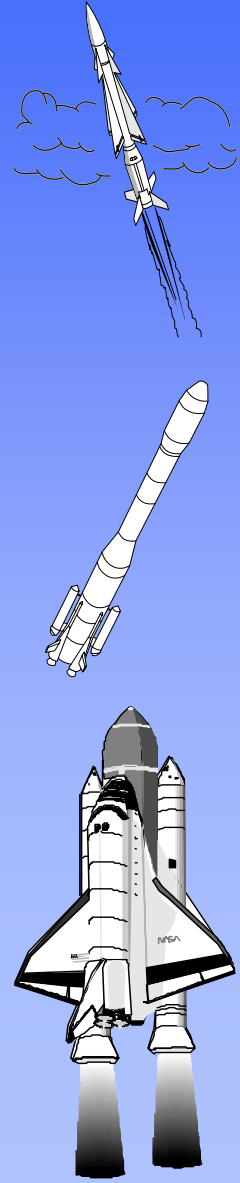


Space Flight



- Why Do It?
 - > Explore the Unknown
 - > Microgravity
 - > Communications
 - > Weather Forecasting
 - > Future Exploration
- How to get up there?

???

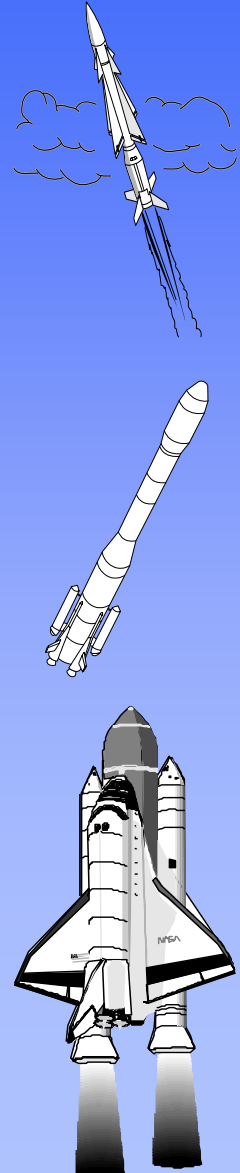
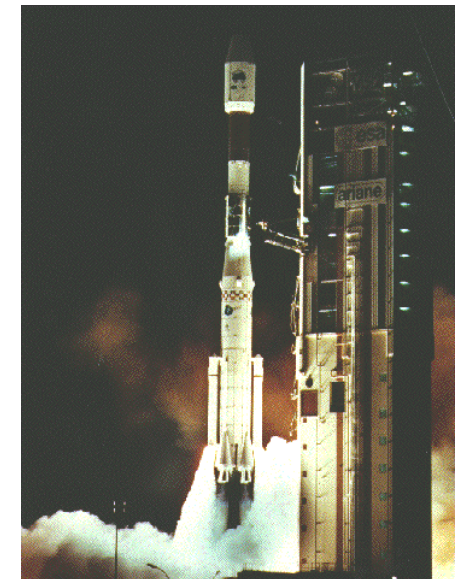


Space Flight

• Boosters & Payloads

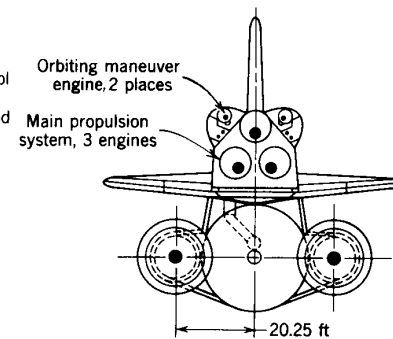
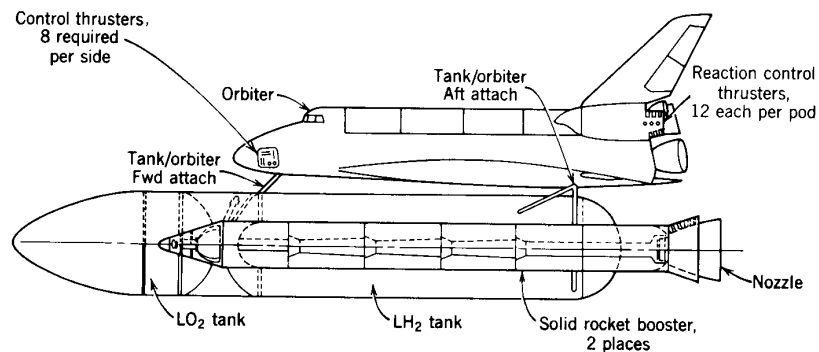
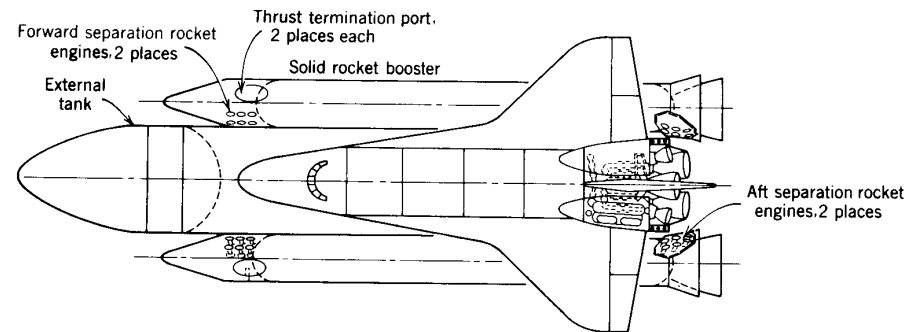
Scout	Pegasus	M-3S-II	Conestoga II	Titan II SLV	Long March 3	H-1	Delta II 7925
DEVELOPER:							
Vought	OSC	Nissan Motors	Space Services Inc.	Martin Marietta	Great Wall Industry	NASDA	McDonnell Douglas
PAYLOAD, KG — TO 200 KM:							
250	455	840	1000	2310	3000	3350	4855

Ariane 40	Atlas G Centaur	H-II	Titan III IUS	Titan IV NUS	Proton	Shuttle IUS
DEVELOPER:						
ESA	General Dynamics	Mitsubishi Heavy Ind.	Martin Marietta	Martin Marietta	SLX -13/12 USSR	Rockwell International
PAYLOAD, MASS TO 200 KM (KG):						
4850-9600	5680	9020	14400	17450	19500	22765



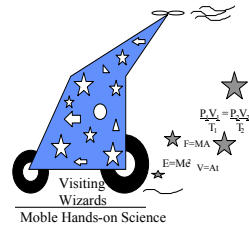
Space Flight

• US Launch Vehicle Example: Space Shuttle



- Complicated and costly equipment
- How do they Work?

Rocket Physics

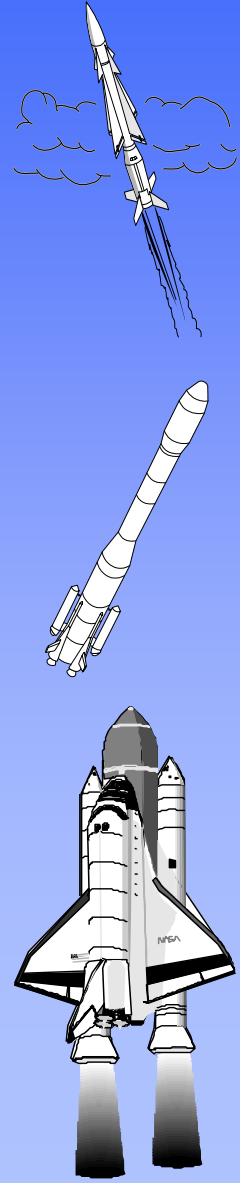


- Governing Principles

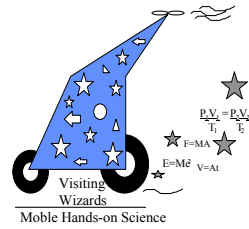
- > Newton's Three Laws
- > Energy Conservation
- > Aerodynamics + Stability
- > Propulsion
- > Vehicle Control + Safety



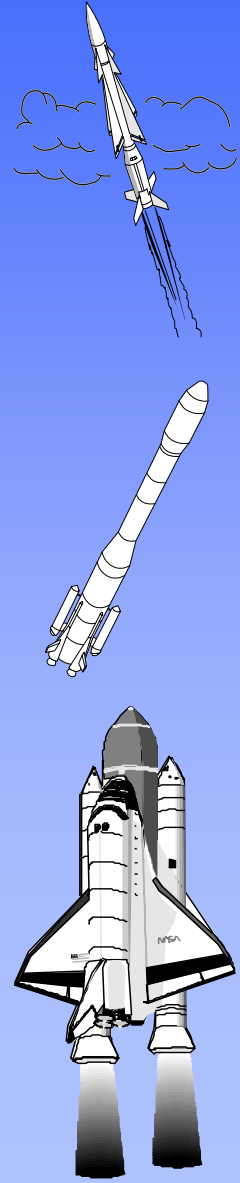
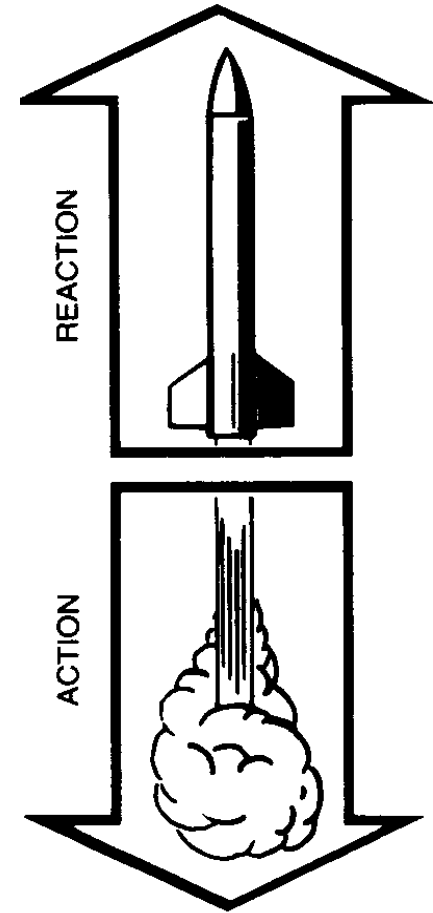
- Model Rocketry is just a scaled version of the Big Rockets!



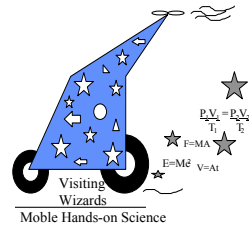
Rocketry Physics



- **Newton's 1st Law (Law of Inertia)**
 - > “Objects at rest will stay at rest and objects in motion will stay in motion in a straight line unless acted on by an outside force.”
- **Newton's 2nd Law ($F=MA$)**
 - > “If an force acts on a body, the body will be accelerated; the magnitude of the accel. is proportional to the magnitude of the force, and the direction of the accel. is in the direction of the acting force.”
- **Newton's 3rd Law (Action-Reaction)**
 - > “For every action there is always an opposite and equal reaction”
- **Energy Conservation**
 - + Energy In= Energy Out & Energy is just converted from one form to another



Rocketry Physics



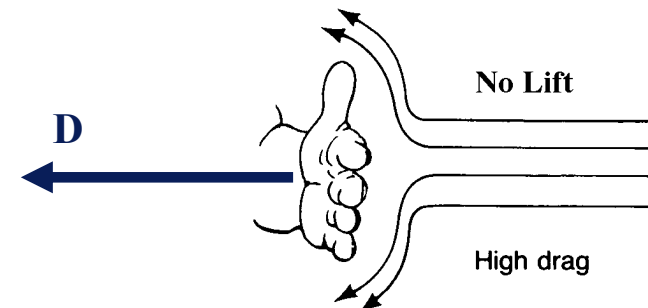
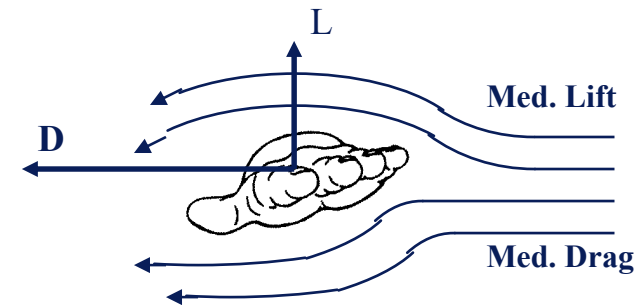
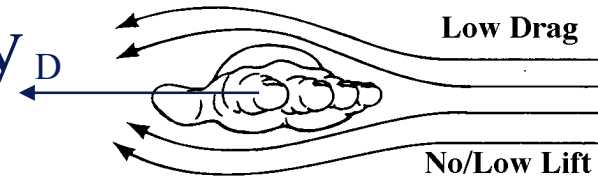
- Aerodynamics and Stability

- > Minimize Drag

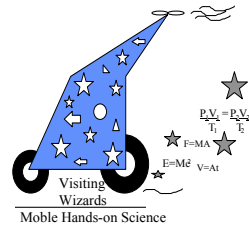
- Frictional
 - Lift Induced

- > Lift Generation

- Lifting Accent
 - Glide Return
 - Maintain Stability

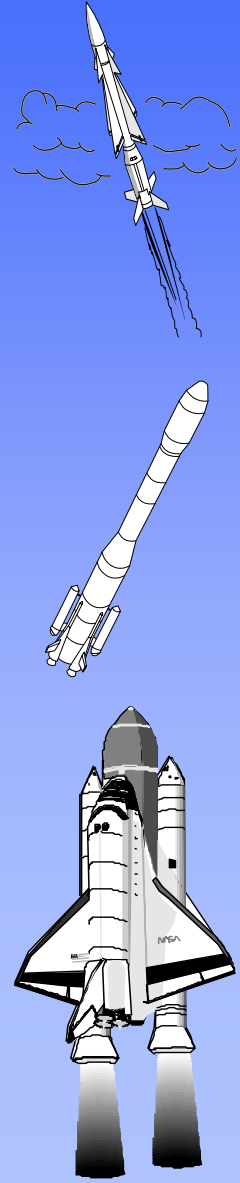


Rocketry Physics

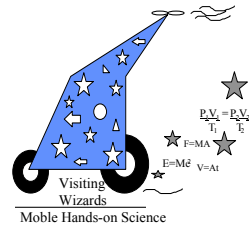


- Propulsion

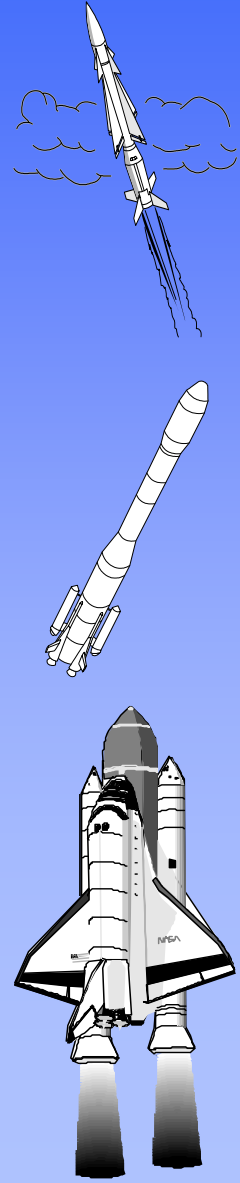
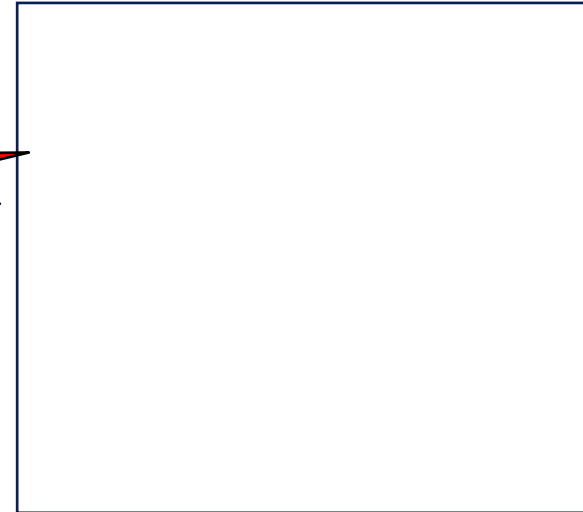
- > Provides the Force to Overcome Gravity and Accelerate the Vehicle
- > Engine Types & Operation
 - Liquid
 - Solid (Model Rocket Engines)



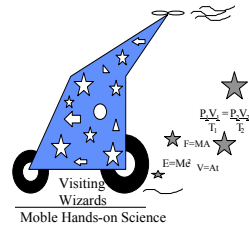
Rocketry Flight Safety



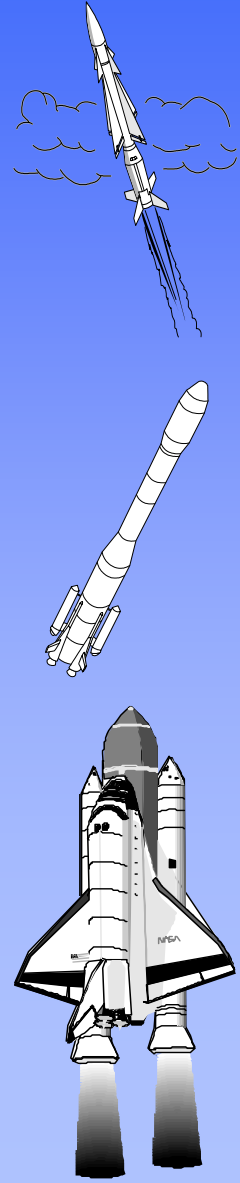
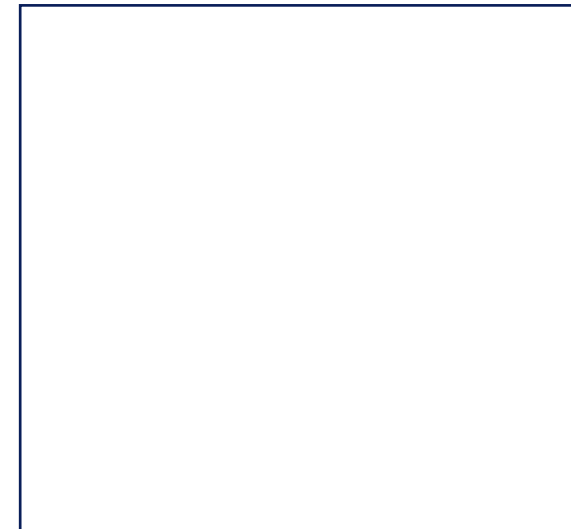
- Propellants
 - > Controlled Explosions
 - > Often Toxic
- Vehicle Control
- Environmental Pollution
 - > HAZMAT
 - > Sound
- Model Rocketry has Similar Concerns



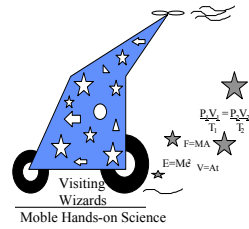
Model Rocketry



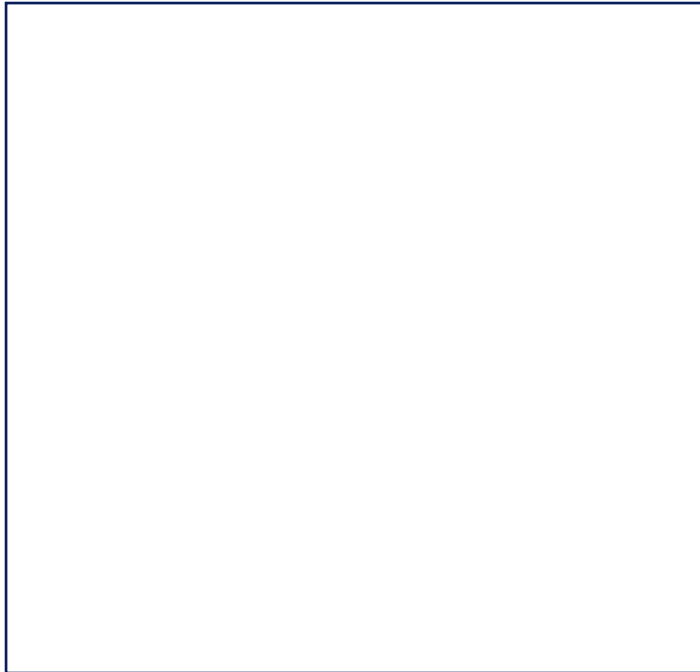
- Scaled Versions of the Big Rockets!
- Physics are the Same
- Look into:
 - > Evolution of Model Rocketry
 - > Rocket Design and Building
 - > Safety Testing
 - > LAUNCHING!



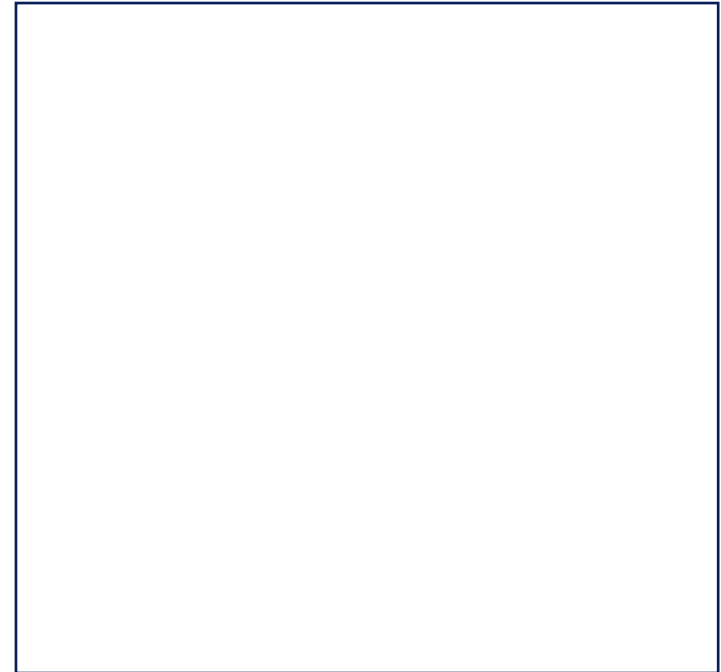
Model Rocketry



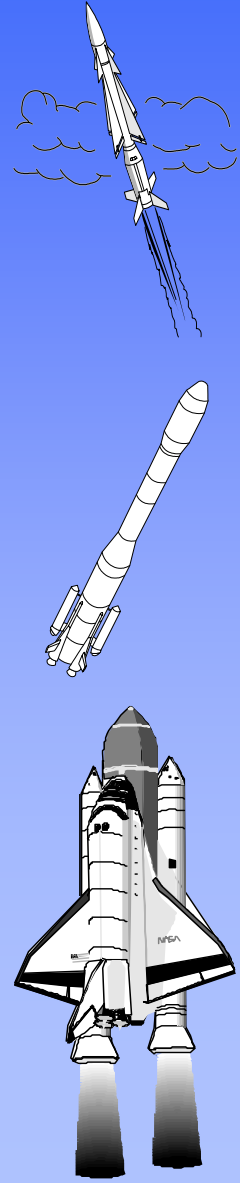
- Evolution of Model Rocketry



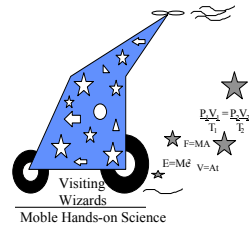
- Amateur Rocketeers or “Basement Bombers”
- Mixed Own Fuels ,
1:7 chance of Serious Injury



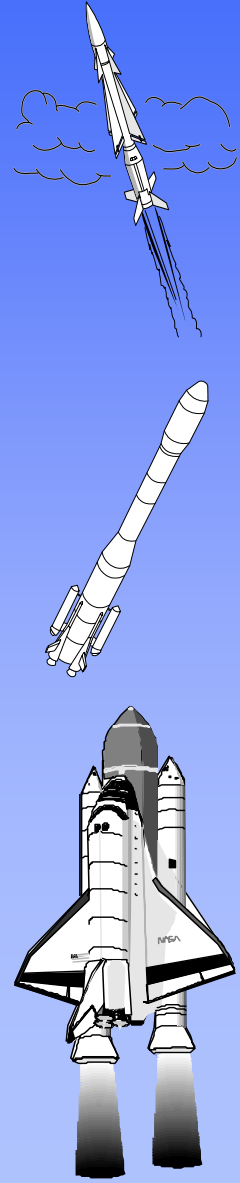
- Professional Rocketeers with formal training, skills, & Equip.
- Safety Proven, Commercially Manufactured Rocket Engines



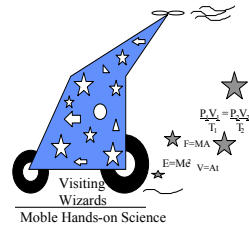
Model Rocketry



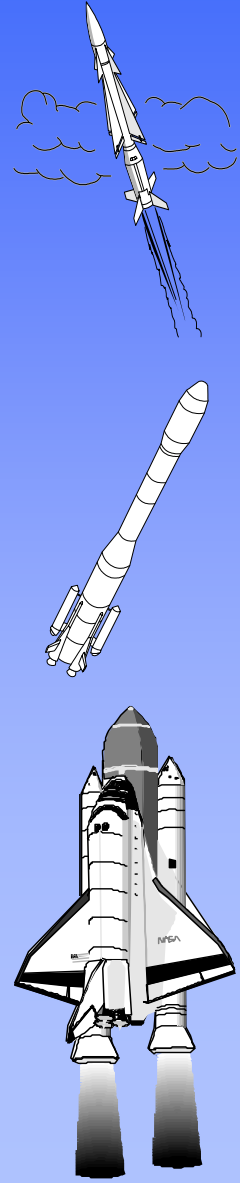
- National Association of Rocketry (NAR)
- Model Rocketry Safety Code



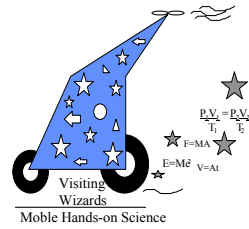
Model Rocketry



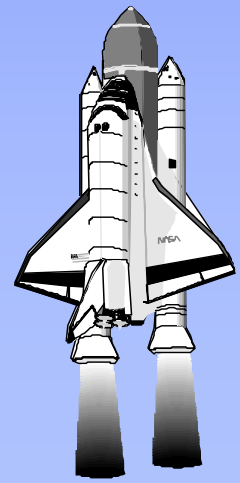
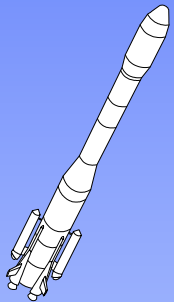
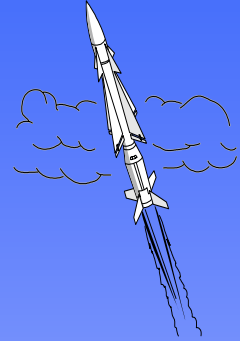
- Model Rocket Components



Model Rocketry

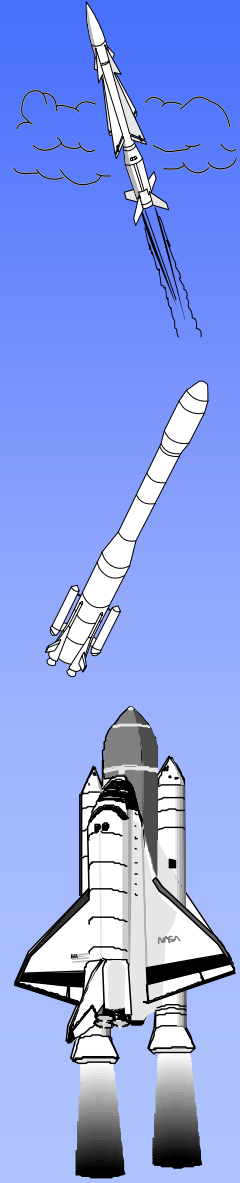


- Propulsion System:
Solid
Rocket
Engines

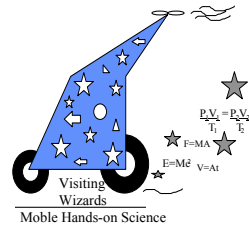


Model Rocketry

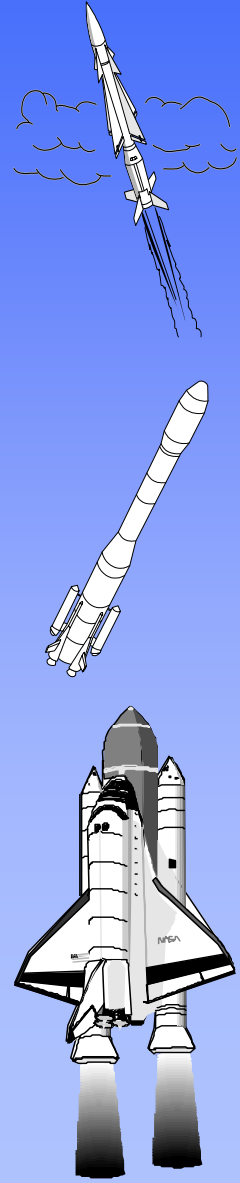
- Recovery Modes/Systems



Model Rocketry



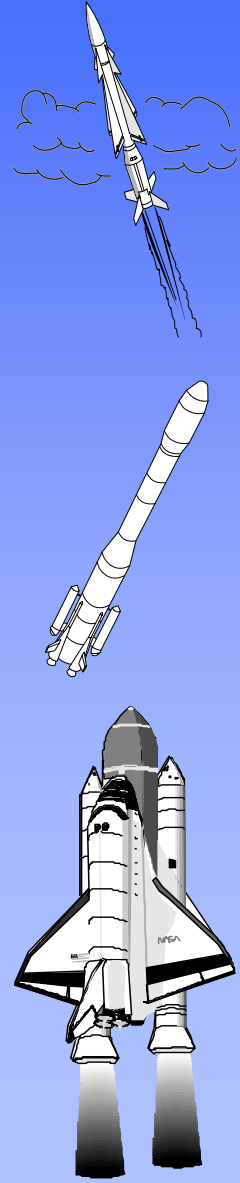
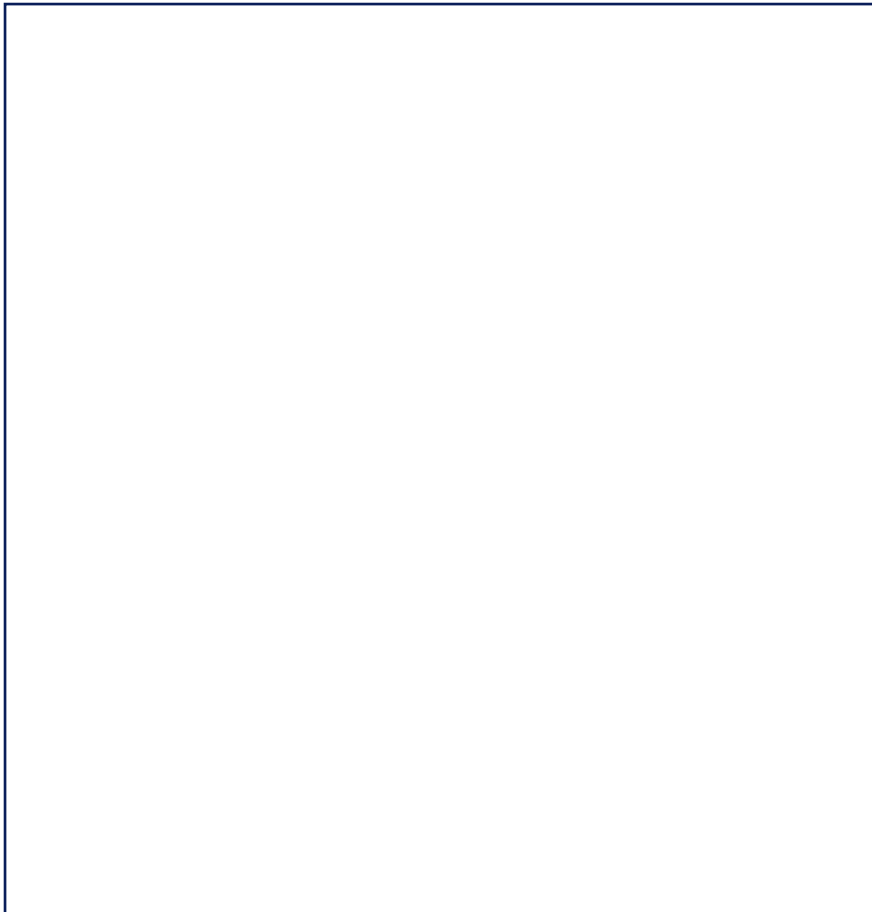
- Aerodynamics & Stability Tests



Model Rocketry

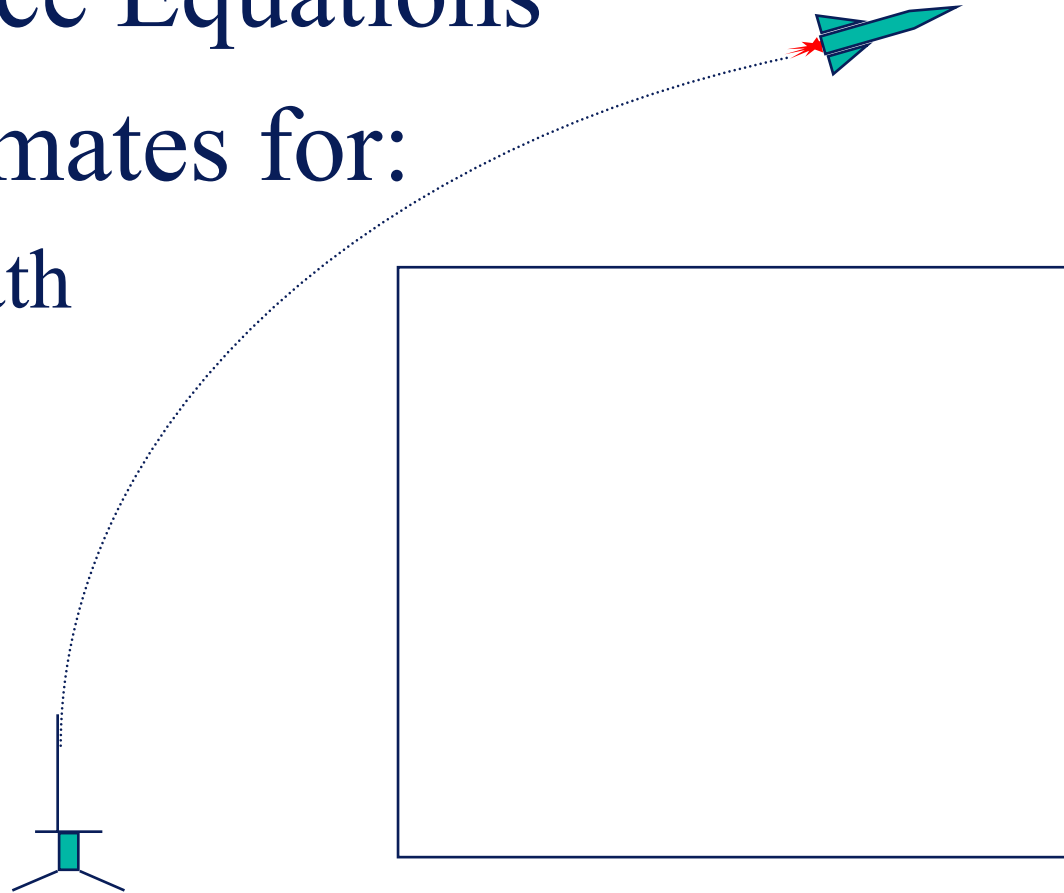
• Flight Phases

- Launch
- Thrust Phase
- Coasting Phase
- Recovery Phase
- Touchdown

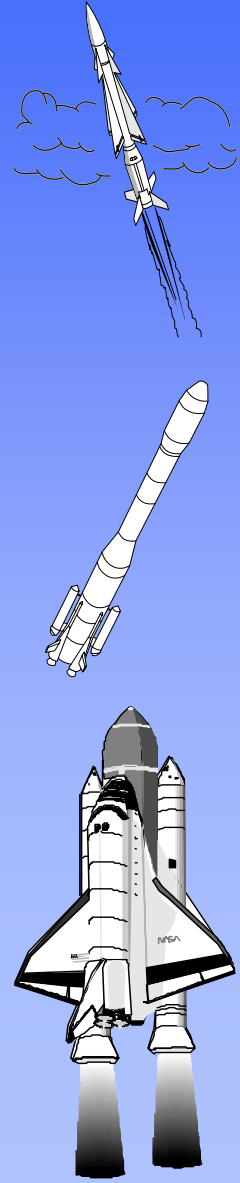


Model Rocketry

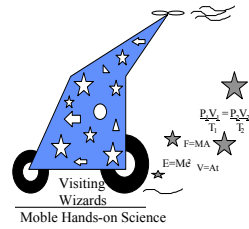
- Performance Equations allow Estimates for:
- Trajectory Path
- Altitude
- Range
- Drag
- Lift



• If interested, Information can be provided through your Teacher!



Model Rocketry



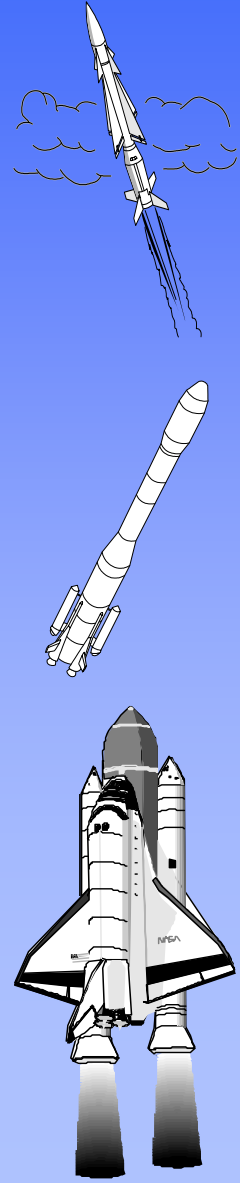
• Competition Areas

> Target Landing

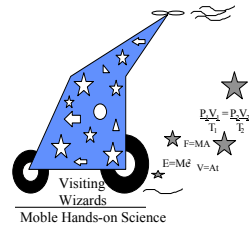
- (5-50) Points for Landing Accuracy
(based on distance to target)
- (5, 10, 20, 30, 40, 50) Points for Maximum Airborne Time
(top 5 positions + 5 pt minimum score)
- (0 or 25) Points for Safe Payload Delivery
(a raw Grade A Large hen's egg, recoverd w/o cracks)

> Model Rocket Design, Originality, & Appearance

- Judged at the start of the competiton
- (1-15) Points for each category



Model Rocketry



• Competition Rules

> Teams of 4-5

- Each team will have at least

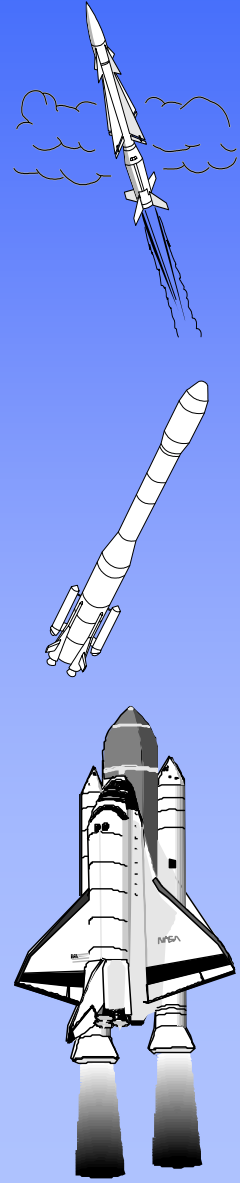
- (1) Launch Control Officer (LCO)
- (1) Tracking Officer (TO)
- (2) Recovery Crew Members

> 2 Launches per Team (A or B Engines only, C with an Egg)

> NAR rules will be followed

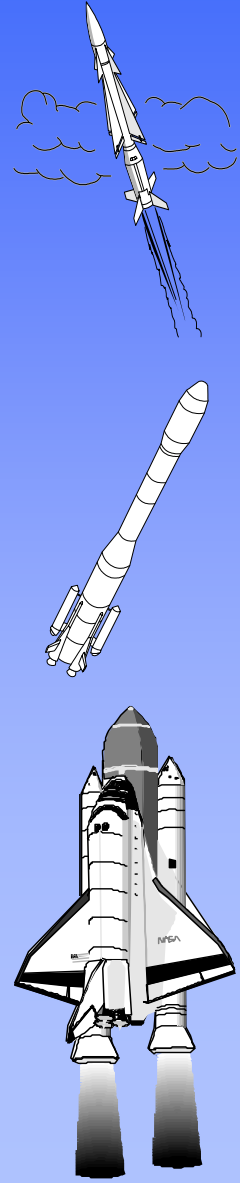
> Range Safety Officer (RSO) will carry safety keys, check air-worthyness/weights of rockets, and give launch clearance for flights.

• Observe launch boundaries at all times!



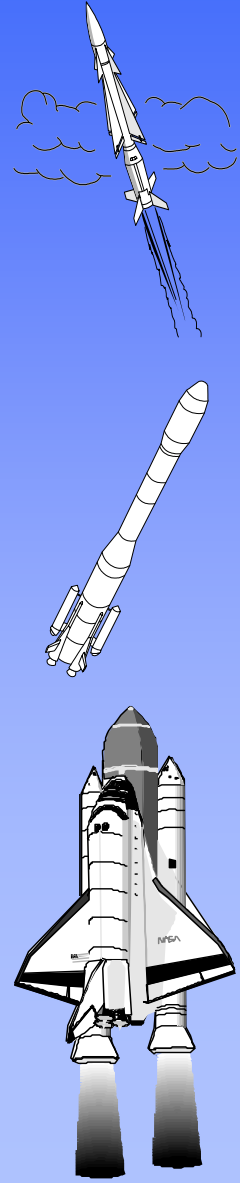
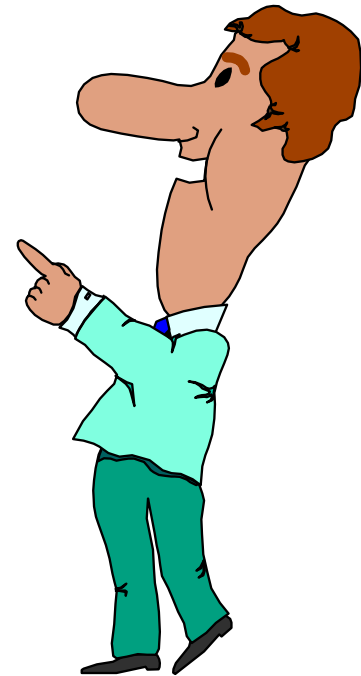
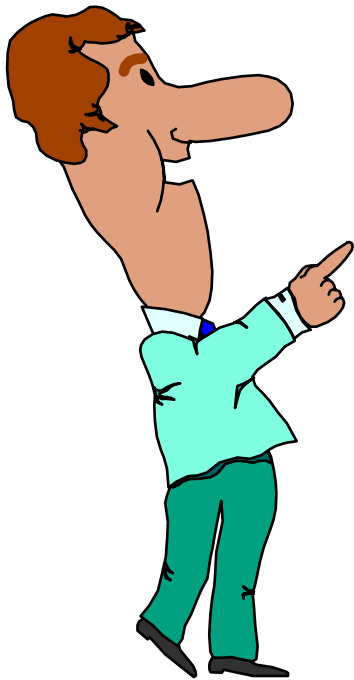
Model Rocketry

- Sample Launch Range Layout

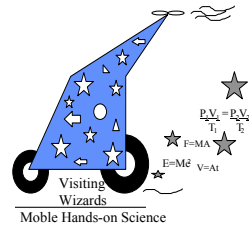


Model Rocketry

Countdown to Competition Launching



References



- Space Mission Analysis and Design, Edited by James R. Wertz and Wiley J. Larson, 1991.
- Rocket Propulsion Elements, by George P. Sutton, 1992
- Estes: The Alpha Book of Model Rocketry, 1988
- Estes Educator: Physics and Model Rockets, by Sylvia Nolte, Edited by Thomas Beach, and Tim Van Milligan, 1992
- Basics of Model Rocketry, by Douglas R. Pratt, 1984

